VR Music Lab: a virtual reality serious game for learning the principles of music composition

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ABSTRACT

Serious games have proved to be a practical learning tool for different fields. Considering learning composition is a tedious process which requires a vast amount of music theory knowledge, we designed VRMusicLab, a virtual reality serious game for people to learn music composition from basics in a motivational and interactive way. VRMusicLab is part of an XR system called 'XRMusicLab' that also features an AR game that completes the experience with a virtual DJ console powered by Leap Motion.

The central concept of VRMusicLab is letting people learn by experimentation. We suggest the users be creative by following patterns and best practices suggested by music experts.

The design is to build music by using interactive objects, like blocks, and build music as a composition of those blocks. We make use of pillars-like objects to give the players a physical representation of the components of the song they are composing.

The game will include two different modes. The first one will be for training and learning music composition; the second will be for experimenting with what the users have learned.

Author Keywords

music, teaching, serious game, education, videogame, digital game, learning through play, motivation, composition, improvisation, virtual reality, music teaching system.

CSS Concepts

• **Human-centred computing~Human computer interaction (HCI)**; *Haptic devices*; User studies; Please use the 2012 Classifiers and see this link to embed them in the text: https://dl.acm.org/ccs/ccs_flat.cfm

INTRODUCTION

Lack of student motivation and engagement in learning is becoming an increasing challenge for music educators because when students disengage from learning, it can lead to classroom disruptions and behavioural

problems. Children dislike practising, so well-known games like Bingo are being used to give them a very workable knowledge of many concepts of music. [6] Evidence emerging from studies in neuroscience suggests that closer attention to the interactions of mind and body illuminate the human need to create, and by extension, our need to create music. [7] Synergies can be obtained by grouping together ideas from music, education and video games. Fun games increase learners' motivation and foster collaboration, crucial issues in music practice. [5]

Digital games can be learning tools, motivators and generators of curiosity. Scepticism and costs are the barriers to their spread even if they are effective. [10] Games like Guitar Hero, Rock Band, Amplitude, Frequency, Rocksmith, Bandfuse, Bit. Trip Complete, Audiosurf, Beat Hazard or Biophilia have educational value; players will self-educate when a topic is introduced in a context that they already enjoy. [8]
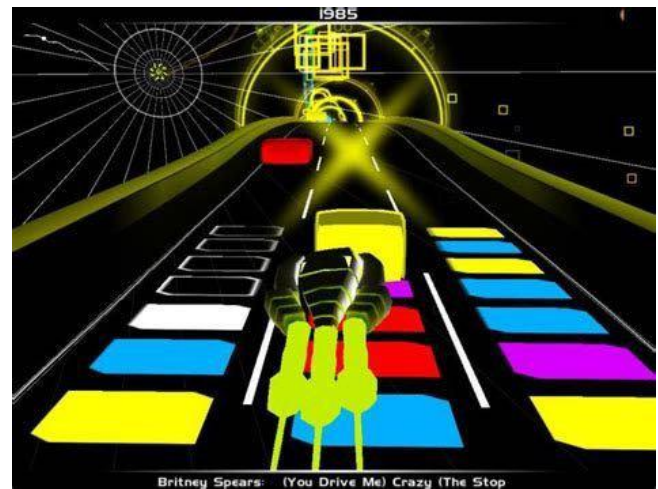

Figure 1. Audiosurf [8]: a music-adapting puzzle racer where you use your own music to create your own experience. The shape, the speed, and the mood of each ride is determined by the song you choose.

A couple of initiatives had already been built around this concept. For example, the Manhattan project [9] explores the use of technology in developing digital pedagogies that bridge learning in both music and programming. A second example is iClef - Music information. It uses symbols, having their graphical representations as scores, their audio renderings as tracks, etc. Making relationships among music contents explicit provides a potentially rich education. [1]

Using this kind of tools, physical engagement resulted in a higher level of concentration on the movements that the child wants to perform, leading gradually then to a lower number of incorrect guesses but a higher average time to complete the game. [12] Also they make the student acquire an intuitive understanding of the knowledge to be learned in order to develop effective strategies to progress within the game and interact with other players. [5]

Embodied cognition theories emphasize the formative role of embodiment (i.e. the way an organism's sensorimotor capacities enable it to successfully interact with the physical environment) in the development of different levels of cognitive skills [11]. The potential of using motion-based interaction for learning is grounded on theoretical approaches that recognize the relationship between physical activity and cognitive processes, and are supported by a growing body of evidence from psychology and neurobiology [11]. For most children, particularly, physical engagement resulted in a higher level of concentration on the movements that the child wants to perform, leading gradually then to a lower number of incorrect guesses but a higher average time to complete the task. [12]

By using new technologies, like virtual reality, the problem of the poor interaction of traditional music teaching methods and the low efficiency of the usage of music teaching resources can be solved. [2] Based on that, the design of a new virtual reality game, to teach the principles of music composition, is going to be tested on this research.

RESEARCH QUESTION
Could a virtual reality serious game be used to teach the principles of music composition?

SCENARIO

Story
You are a newborn God of Music and you are given the mission of bringing the music "back" to the world by learning step by step all the fundamental concepts and tools needed to compose music. However, other minor Gods also want to do it, so you have to do your best to prove your ability.

During your apprenticeship, you will be guided by the Supreme God of Music into the main aspects of music composition until you'll be able to freely experiment and create on your own. Follow the training to complete your achievements and unlock new powerful tools.

Game
At the beginning of the game, the player will spawn into the player area, a floating green circle from where he/she will be able to control surrounding objects. The Supreme God of Music will instruct him about his available powers and how to use them to interact with surrounding objects. There are 2

possible interactions: with the pillars around the player area, also called *totems*, and with the tools that the user has on his/her wrists and hands.

The goal of the first level is to understand these two mechanics and all related commands and use them to build your first song.

DESIGN

Music composition principles
According to Kaschub (2009)[7], music composition starts with an intention, and it could be based on a memory of a feeling. A composer must be able to capture a "feeling memory" and how it comes into conscious being, known as the sound and silence principle. Teachers often engage in sound explorations activities in classrooms that include focused listening for one minute and then noting a list of everything heard in the environment. Our game starts using this principle, introducing the player to the environment and the sounds he can get from it, inviting him to a focused listening activity. The player must pick one sound that gives him a "feeling memory" to start with the composition.

Lupton & Bruce (2010) introduces us to a composition pedagogical model with three themes: (1) Learning from the masters; (2) Mastery of techniques; (3) Exploring ideas; and (4) Developing voice.

The first two themes deal with content to be learned, while the third and fourth themes deal with the creative process. In that sense, our game introduces a "master": the Supreme God, that shows the player how he embraces composition, so he can learn from watching and emulating the master's style. The mastery of techniques is addressed when the player is encouraged to try the techniques and repeat them to achieve different creations. After the player concludes this first tutorial, he is encouraged to theme three and explores his ideas, by revising and extending their work. In this version, we provide a way to change the melody key and tempo with that purpose.

Finally, the fourth theme: developing voice, is shown as the most underdeveloped in terms of teaching strategies. So the main suggestion is about giving the composers the freedom to find their own creative impetus, resulting in a personal style and individual expression. [13] In that way we introduce the game as a music lab for future use and discovery.

Experts feedback
During the design process, we had the possibility to interview 2 experts in the field. The first one is a Music Composer and Producer, nominated for Grammy Awards, and he told us how hard it can be finding inspiration for composing music. His main point was about the fact that you don't really need an instrument to learn music, you can get started as well with your own voice or anything that can produce sounds. Most important, you don't need to be a

musician to start making music, many people that work in the industry don't have a deep knowledge of music theory. Learning music composition is like learning to write a book: you need to read a lot of books to get inspired and to understand how you could structure your own, same goes with music. He also emphasized the importance of having an inspirational environment for music composition. He entirely designed his studio to make him comfortable and inspired while he is working.

The second person we interviewed is a professional DJ that has different albums published, he is mostly a self-taught composer and in his experience learning the tools and the music theory at the same time has been extenuating and overwhelming. He almost gave up many times until he discovered Logic Pro and fell in love with the UI. Now when he works, he needs to be in an isolated environment where he can freely experiment and get into the flow.

Freedom of experimentation
The central concept we wanted to build our experience around is experimentation. Music students often feel intimidated in front of a teacher, especially if they are not self-confident, and are afraid to make something "wrong".

In the virtual world, we built they are gods themselves and even if there is a Supreme God guiding them, he is only a tutor giving advice instead of orders. The more the player unlocks the tools he/she needs to compose music, the more he/she is pushed into free experimentation.
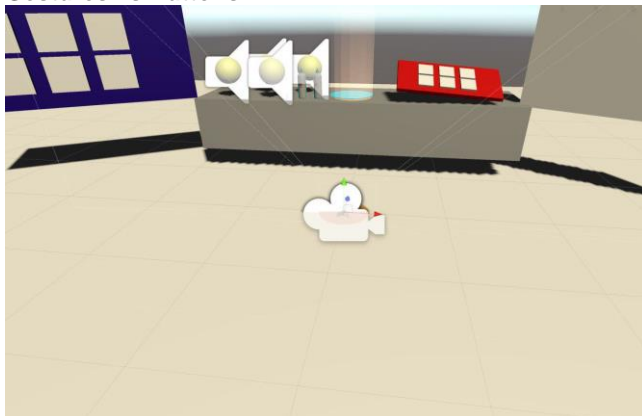
Gestures vs Buttons

Figure 2. First prototype of VRmusicLab environment: grab the yellow ball to listen to beats. Throw them to tracks to compose songs.

The first iteration of our prototype envisioned a futuristic DJ console in a floating room. On the console there would be buttons and spheres that combined together could be used to compose a song. After showing it with the first group of potential players, we realized there was a big problem in this approach: this console was not really taking advantage of the virtual world interactions more than any software for DJs. It was simpler and simplicity is something we wanted to keep,

fully-featured software can be overwhelming to learn and that would push away people with little no knowledge of them.

The second iteration of the prototype is set as well in a floating room, but now every command is embedded in the user's hands. Hands interactions will be triggered by controllers buttons and allow the user to use any of the tools provided (and unlocked) directly in his/her hands instead of moving them on a console.
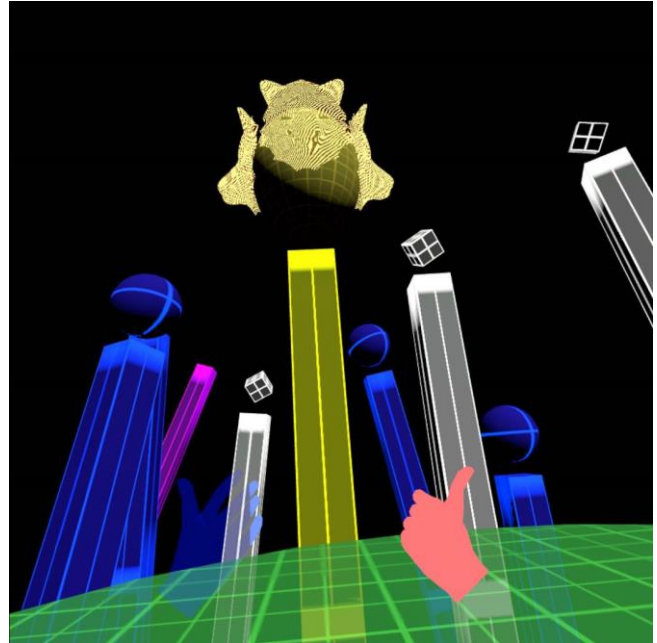
PROTOTYPE

Figure 3. Second prototype of VRmusicLab: Player area with the music Totem.

Functionalities
Totems are the containers used for music, they could be of 2 different types:

- *Beat Totems* contain beats, they have a glowing sphere on the top and are blue coloured.
- *Melody Totems* contain melodies and their colour changes according to the selected chord.

Totems are opaque if they are inactive. When activated, all totems start glowing following the *tempo* of the song. The player can perform a set of actions to interact with totems using gestures:

1. *Point and click:* this action will *activate( )* or *deactivate( )* a totem depending on its current state.
2. *Point and Drag Up/Down*: this action will move the totem up and down changing the volume of the audio source being played.

Player's hands and wrist have embedded tools. On the wrists, the player has an indicator for the current key for the chords

while in the hands he/she has an invisible controller for the *tempo* of the song. The following set of actions will enable to interact with them:

1. *Touch the Key selector:* this action has to be performed with the opposite hand, it will change the current key.
2. *Click and Hold both Grip buttons*: this action will make the *tempo controller* visible and "stretchable".
3. *Stretch Tempo Controller*: stretching the *tempo controller* will increase/decrease the bpm of the *tempo*.

After a song is complete, it can be saved in a non-relational database.

EVALUATION METHOD

Music composition and music composition teaching are hard, frustrating and often boring. Our teaching method is based on the concepts of "learning by doing" and "active learning" to motivate the students without overwhelming them with notions. Using virtual reality, the problem of the poor interaction of traditional music teaching methods and the low efficiency of the usage of music teaching resources can be solved or, at least, mitigated. In order to evaluate the impact of this game on a group of potential learners, we propose the following methodology taken from the Game-Based Learning protocol:

1. Select a test group that is going to be asked to play our game and to follow a video class of music composition principles. People attending are expected to be interested in learning music composition but are not already expert musicians.
2. At the end they must fill a questionnaire that asks for:
    a. Learning outcomes: specific questions about music composition principles
    b. Learning experience: how much they enjoyed both situations
    c. Experimenting: if they felt like experimenting and practising the techniques on their own
    d. Overall motivation: how much they feel inspired to continue on the music composition field
3. Results must be tabulated and compared to lead to conclusions.

What we want to measure is the effectiveness of the Game-Based Learning experience applied to the specific field of music composition, in particular how much the learners feel involved and motivated in going on with the game rather than following some standard technique, and also if we can get learning outcomes from this.

Rather than a comparative measurement of principles' quantity learned in the same amount of time, we want to compare the enjoyment of the students and the likelihood they will go on studying music composition or experimenting the techniques they have learned.

DISCUSSION AND FUTURE WORK

God Mode and Challenges

The game is designed for people who struggle in learning music principles, because of lack of motivation, or knowledge or confidence. But at some point of the game, once they have mastered all the basic principles, they will reach the status of "God of Music". We think about God Mode as the true experimentation mode that we would like the game to be. At this point in the game, players will have enough confidence to be challenged with harder tasks and to climb the learning curve of music composition.

Collaboration

An important aspect of the idea is that the game is part of a system. We wanted to foster collaboration between VR and AR players also as part of the lore: the Gods of Music want to share their creations with the humans and AR feels like the perfect window for the real world to look into the virtual world. To make this collaboration possible we are working on a standard set of objects that can be used in both applications. In this way, the creation in the virtual world can be shown and edited in the real world through the augmented console.

Music assets

As far as we can give the player more options to be used to improve their composition, he can make more advanced creations. Future versions should include additional beats, sound effects and tools to improve the "lab". That is also important to build into the fourth theme of the composition pedagogical model we're basing the learning process and help the player to find his own voice.

MIDI controller with Chuck

ChucK is a programming language for real-time sound synthesis and music creation. Through Chuckunity, which is a plugin embeds ChucK as a native audio plugin in Unity, the communication between ChucK and Unity can be realized by using ChucK global variables. Furthermore, ChucK supports MIDI, OpenSoundControl, and HID devices. By implementing Chuck for audio synthesis in our development could also give potential to turn VRmusicLab into an interactive productive tool.

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